



DIANE FOSTER

PROMETHIUM

Element Symbol: **Pm**

Atomic Number: **61**

An initiative of IYC 2011 brought to you by the RACI



International Year of
CHEMISTRY
2011



Royal Australian Chemical Institute

www.raci.org.au

PROMETHIUM

Element symbol: Pm

Atomic number: 61

Promethium is element number 61 and is one of the so-called rare-earth elements or lanthanides. It lies in the 6th period of the Periodic Table of Elements. Promethium is exceptional in that all the known isotopes of Pm are unstable. The only other element sharing this feature is Technetium (Tc, atomic number 43). The lifetime of the most stable isotope of Promethium, Pm-145, is just 17.7 years, and consequently, Pm and Tc share the dubious honour of not being found on earth, except in incredibly small concentrations (1 part in 10¹⁶) in pitchblende, as a by-product from fission of natural uranium. The total amount estimated to exist in the earth's crust due to U-238 fission is 450g, with another 12 g due to a secondary pathway involving the fission of radioactive Europium-151. However, it has also been observed spectroscopically in the spectrum of stars. Consequently, all our knowledge of this element comes from studies of the small amounts synthesised by nuclear chemistry from nuclear fuel.

Historically, Promethium was first predicted to exist in 1902 by the brilliant British physicist Moseley. Jacob Marinsky, Lawrence Glendenin and Charles Coryell are equally credited with the purification of the uranium fission fuel products and the isolation of promethium. In 1963 using ion-exchange columns 10 grams of it was prepared from nuclear fuel wastes.

The longest liver isotope, Pm-145, is a soft beta emitter - i.e. it emits high energy electrons, while Pm-146 has a half-life of 5.53 years and Pm-147 has a half life of 2.62 years. However some 27 isotopes are known but the half-lives of almost all of them are less than half a minute! Samples of Pm can emit x-rays, but this is due to the secondary reactions of the emitted electrons with materials near the isotopes. Because it is highly radioactive, salts of Promethium luminesce in the dark with a blue or greenish glow. Decay produces primarily neodymium and samarium atoms. It is moderately dense at 7.26 g/cm³, making it denser than iron (5.6 g/cm³) but less dense than silver (10.2 g/cm³). Chemically, Pm behaves like other lanthanides; it is a very electropositive metal and oxidizes readily in air at just 150°C to form Pm(III) oxide, Pm₂O₃. It also reacts readily with halogens. When purified from nuclear waste, it is generally converted first into PmF₃. This is then reduced with metallic calcium. Some 30 compounds of promethium are known.

The name Promethium was proposed in 1948 and accepted by the International Union of Chemistry in 1949. It comes from the name Prometheus, the Greek God who stole Fire from the Gods for human benefit. Thus far, its uses have been quite limited, due to the expense of synthesising it, and the fact it is likely to be quite toxic. The primary applications for Pm are solely due to its radioactivity. Further uses are as the power source in nuclear batteries, and as an auxiliary heat or power source for space probes and satellites. Exciting, newer applications include "betavoltaic microbatteries" for applications including heart pacemakers.

Provided by the element sponsor Paul Mulvaney

ARTISTS DESCRIPTION

I was immediately drawn to the origins of the name, taken from Greek mythology. Prometheus was a demi-god and one of the Titans who defied Zeus by stealing fire from the sun and giving it to man. Zeus was angry at the power given to man and chained Prometheus to a high rock in the blazing sun, where a vulture ate his liver which grew again as fast as it was devoured. He was eventually rescued by Hercules.

Promethium is a radio-active rare earth metal of the lanthanide series, first produced artificially in a nuclear reactor in 1963. It occurs in nature in traces as a product of uranium fission. Little is known about its properties and it has never been found naturally in the earth's crust.

DIANE FOSTER